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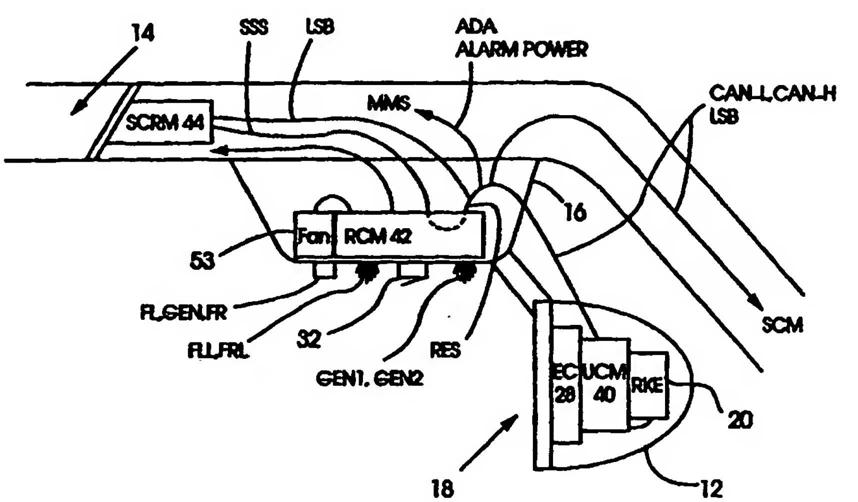
(54) Title: A VEHICLE REARVIEW MIRROR AND A VEHICLE CONTROL SYSTEM INCORPORATING SUCH MIRROR



(57) Abstract

A vehicle control system comprises an industry standard CAN network with a number of nodes distributed around the vehicle for controlling corresponding parts of the vehicle. One such node (40) is located in the housing (12) of the vehicle interior rearview mirror (18) and directly controls the reflectivity of an electro-optic mirror unit (28), in accordance with the state of at least one ambient light sensor, and a remote keyless entry device (20). The node (40) also communicates via an ISO9141 interface with a number of slave controllers such as a sun-roof control module (44) mounted adjacent a sun-roof (14) and a roof control module (42) mounted in a roof housing (16). By this means the UCM (40) exercises indirect control of the sun-roof (14) in accordance with the state of a switch (32), and exercises indirect control of various lamps GEN1, GEN2, FLL and FRL in the roof housing (16) in accordance with the state of switches Gen, FL and FR mounted in the roof housing (16) or, in the case of the lamps GEN1 and GEN2, when a vehicle door is opened.

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A VEHICLE REARVIEW MIRROR AND A VEHICLE CONTROL SYSTEM INCORPORATING SUCH MIRROR

The present invention relates to a vehicle rearview mirror and a vehicle control system incorporating such mirror.

According to the present invention there is provided a vehicle rearview mirror comprising a mirror housing containing a variable reflectivity mirror unit and a microcontroller for controlling the reflectivity of the mirror unit.

There is also provided, as a further independent invention, a vehicle control system comprising a rearview mirror housing, a variable reflectivity mirror unit mounted in the mirror housing, a master microcontroller mounted in the mirror housing for controlling the reflectivity of the mirror unit, a roof housing positioned on the interior roof of the vehicle, a slave microcontroller mounted in the roof housing and connected to the master microcontroller, and at least one input and/or output device connected to the slave microcontroller.

There is also provided, as a further independent invention, a vehicle control system comprising a network controlling a plurality of functions of the vehicle, the network having a node located in a rearview mirror housing of the vehicle, such node controlling at least one function of the mirror.

There is also provided, as a further independent invention, apparatus for controlling an optical characteristic of a vehicle component in accordance with the duty cycle of a pulse width modulated signal.

An embodiment of the invention will now be described, by way of example, with reference to the accompanying drawings, in which:

Figure 1 is a schematic view of a vehicle including a control system according to the invention;

Figure 2 is a schematic view of the upper windscreen and front roof area of the vehicle and control system of Figure 1;

Figure 3 is a block circuit diagram of the UCM 40 in the rearview mirror housing of Figure 2 for use with a first embodiment of the RCM 42 in the roof housing of Figure 2;

Figure 4 is a block circuit diagram of the first embodiment of the RCM 42 in the roof housing of Figure 2;

Figure 5 is a flow diagram illustrating the method by which the node of Figure 3 controls the reflectivity of an electro-optic mirror; and

Figure 6 is a block circuit diagram of a second embodiment of the RCM 42 in the roof housing of Figure 2.

Referring now to the drawings wherein similar numerals have been used to indicate like parts, a vehicle control system comprises a network of nodes 10 distributed about the vehicle 11. Each node 10 controls the operation of particular part of the vehicle, e.g. the engine, brakes, door locks, etc. In the embodiment of the invention, one of the nodes, identified as UCM 40 in Fig. 1, is

located in the housing of the vehicle interior rear view mirror as will be described.

Each node 10 in the network communicates with each other node using an industry standard CAN (Controller Area Network) network protocol. A CAN network is a multi-master CSMA/CA (carrier sense multiple access collision avoidance) arbitrated bus, such as has been developed by Bosch specifically for use in the automotive industry where it is critical that messages be executed within a pre-determined time span; see, for example, PCT Application Nos. WO 90/01739 and WO 94/06081. Each node includes a controller having a back end and a front end. The back end of the controller is connected to sensors and actuators while the front end communicates with each of the other node front ends across a two-wire bus, CAN_H, CAN_L.

The front end of each node controller in a CAN network has a memory containing a table of node-specific message identifiers. Only messages with these identifiers can be transmitted or received by the node. There is a maximum of 2048 identifiers. For transmission, the back end of the controller writes a message to a message buffer in the front end controller and sets a flag. The transmission is then automatically executed by the front end of the controller. The front end decides whether to process a message placed on the network by any other node using an acceptance filter. The criterion for this decision is the identifier included in every message. Only messages, which pass the acceptance filter are stored in the receive buffer and transferred to the back end controllers memory.

There are a number of available microcontrollers

incorporating CAN controllers, for example, a Motorola MC68HC08AZ0. Other examples of CAN controllers are Philips PCA 82C200 or Intel 82526. These controllers enable nodes to communicate with one another to transmit the status of sensors or actuators across the network. It will be seen that because only a two-wire bus is required to connect each of the nodes on the network together, significant weight savings can be made in the vehicle's electrical harness for the same level of functionality.

In the present embodiment, a CAN node 40 for controlling electronic equipment in the upper area of the vehicle, referred to as a UCM (upper control module), is located inside the housing 12 of an interior rearview mirror 18, Figure 2. It is advantageous to place the UCM 40 in the mirror housing as it is less susceptible to noise and excess temperatures than if it were located in or adjacent the roof cavity of the vehicle. It is therefore possible to use a controller and associated electronics with a lower temperature rating than if the UCM 40 were placed in the roof cavity. If a higher rated controller is used, however, it can perform more reliably than if it were located in the roof cavity.

The mirror 18 contains an electro-optic mirror unit, that is, a mirror unit of a type whose reflectivity can be varied as a function of an applied voltage. In the present embodiment the mirror unit comprises an electro-optic cell (EC) 28. As is well known, an electro-optic cell comprises an electro-optic medium such as an electrochromic or liquid crystal material sandwiched between a pair of, usually, glass plates. When a voltage is applied across the layer it colours, or darkens, to decrease the transmissivity of the cell, the amount of

darkening increasing with increasing voltage. Within the mirror housing 12 the cell 28 is located in front of a reflecting surface (or alternatively the reflecting surface may be formed directly on one of the glass plates) so that, as seen by the driver, the reflectivity of the mirror decreases with increasing voltage. The construction and operation of such mirrors is very well known in the art; see, for example, U.S. Patent Nos. 5,140,455, 5,572,354 and 5,151,816, and European Application No. 92308022.0, or as described for example in the following papers: N.R. Lynam, "Electrochromic Automotive Day/Mirrors", SAE Technical Paper Series, 870636 (1978); N.R. Lynam, "Smart Windows for Automobiles", SAE Technical Paper Series, 900419 (1990); N.R. Lynam and A. Agrawal, "Automotive Applications of Chromogenic Materials", Large Area Chromogenics: Materials & Devices for Transmittance Control, C.M. Lampert and C.G. Granquist, eds., Optical Eng'g Press, Washington (1990).

In the present embodiment, electronic equipment in the upper area of the vehicle is controlled by or communicates with the UCM 40 and includes the electro-optic cell (EC) 28 of the mirror 18, a remote keyless entry (RKE) unit 20, a vehicle sun-roof 14, an alarm siren (not shown), and various lamps, switches and other equipment contained in a roof housing 16 positioned on the interior roof of the vehicle. The UCM 40 controls, inter alia, the cell 28 and the RKE unit 20 directly, but controls the other equipment indirectly via respective slave controllers which communicate with the UCM 40 via a local sector network which, in the present embodiment, is a half-duplex master-slave network. These other controllers are a roof control module (RCM) 42 located in the roof housing 16, a siren control module (SCM, not shown) and a sun-roof control

module (SRCM) 44. In the present embodiment, master-slave communication is implemented across a conventional single-wire interface complying with ISO9141 referred to hereafter as LSB.

Turning now to Figure 3, the UCM 40 of the present embodiment includes a Motorola MC68H08 microcontroller 22 mounted on a printed circuit board (PCB) within the mirror housing 12. The controller is connected to the CAN bus via a CAN interface circuit 23 which includes a Philips PCA82C250 CAN transceiver. The transceiver complies with ISO/DIS 11898 and converts the two-wire CAN bus signal into separate Rx and Tx signal lines which connect to respective input and output pins on the controller 22.

The controller 22 is connected to an input circuit 24 and an output circuit 26 for controlling the transmissivity of the electro-optic cell 28 and hence the reflectivity of the mirror 18.

The input circuit 24 comprises a series of three resistors RA, RG and RB which are used to determine the ambient light levels around the vehicle. Both RA and RG are light dependent resistors whose resistance is inversely proportional to the level of light falling on them. RA and RB are incorporated in respective ambient light sensors facing forwardly and rearwardly of the vehicle respectively. Since the construction and operation of such sensors is well known only the electrically operative part, the resistors themselves, are shown in the drawings. The node between RG and RA is connected via buffer circuitry 32 to an analog input pin Vglare of the controller. In conditions where the vehicle is lit primarily from the rear by the headlights of another vehicle, the level of light falling on RG

exceeds that falling on RA and the voltage drop across RG decreases. Vglare thus decreases which, as will be seen in Fig. 5 to be described, causes the controller 22 to decrease the transmissivity of EC 28 and hence decrease the reflectivity of the mirror 18.

It is desirable to assess the overall ambient light level in determining the mirror reflectivity so that the degree of control can be reduced in daylight or relatively bright ambient conditions. RB is a constant value resistor and the node between RB and RG is connected via a biasing resistor 34 to an analog input pin Vec_cutoff of the controller 22. Thus, in brightening conditions, as the aggregate light level falling on resistors RA and RG increases and their resistance decreases, the voltage drop across RB also increases by a corresponding level. It will be seen that the increasing voltage drop across RB causes Vec_cutoff to rise gradually, and thus as the overall ambient light level increases the degree of control gradually decreases as also will be seen in Fig. 5.

The output circuit 26 drives the electro-optic cell 28 via a digital pulse width modulated (PWM) output pin PWM EC to control the mirror reflectivity. In the present case the output pin PWM EC provides a voltage level of 5 volts when it is on, and zero volts when it is off. PWM control obviates the need for either an internal or an externally addressed DAC. It will be seen that by separating the input circuit 24 and the output circuit 26 with the UCM microcontroller, the UCM is able to assert intelligent software control over the mirror reflectivity.

The cell 28 is connected to the controller 22 via a two pin connector CN1 on the UCM PCB or alternatively the

connection may be made with soldered wires. A voltage difference of 1.4V supplied to the cell 28 across the two pins of the connector is sufficient to drive the cell to minimum transmissivity and hence reduce the mirror reflectivity to a minimum, while the absence of a voltage difference between the two pins clears the cell. Therefore, a pair of resistors RD1 (100K) and RD2 (39K) are used to divide the 5 volts on the output pin PWM EC of the controller in the ratio 28:72, providing 1.4V at the junction of the resistors RD1 and RD2 for a constant 5 volts at PWM EC.

The 5 volt output signal at PWM EC is modulated by the controller 22 under software control (Fig. 5) to have an on/off duty cycle between 0 and 100%. A capacitor C23, connected in parallel with resistor RD2, is used to smooth PWM EC signals with a duty cycle less than 100% to a substantially constant voltage between 0 and 1.4V in proportion to the duty cycle. The value of the capacitor C23 is chosen as 1uF so that the corner frequency of the filter comprising RD1, RD2 and C23 is significantly below the frequency of the PWM signal to provide a smooth DC signal. A buffer circuit 57 is connected between the voltage divided output signal and the connector pin to provide a high impedance quick clearing output to the cell 28.

Microprocessor control of the cell 28 enables parameters controlling the level of mirror reflectivity to be programmed. These parameters are:

1. A threshold ambient light level at which the mirror should be cleared, (Vec_off);

2. Gain (G); and

3. Start of colour (Cs)

These three programmable parameters are stored in reprogrammable, non-volatile memory and are updated from a computer which plugs into the CAN bus.

Once initiated, a software routine, Fig. 5, runs continually on the controller 22 and monitors Vec_cutoff and Vglare to determine the duty cycle of the 5volt signal at the PWM EC output pin. The routine first checks at step 52 whether the vehicle is in reverse. If so, the mirror is cleared at step 54 by setting the desired value of the duty cycle of the PWM EC signal to 0% and updating the duty cycle accordingly at step 66. If not, Vec_cutoff is measured at step 56. The routine then checks at step 58 if Vec_cutoff is greater than the pre-programmed threshold level Vec_off. If so, the mirror is cleared as before at steps 54 and 66.

The routine continues by measuring Vglare at step 60 and the duty cycle of PWM EC is calculated at step 62 using the formula:

Gain x (Start of colour - Vglare)

If this formula produces a negative value, as determined at step 64, which is possible if Cs is set low, then the cell is cleared at step 54. Otherwise the duty cycle of PWM EC is updated at step 66 to the value calculated at step 62, whereupon the routine waits for a pre-determined delay 68 before returning to step 52.

Returning to Fig. 3, the controller 22 communicates with each of the RCM, SCM and SRCM slave controllers via the single-wire bus LSB. The half-duplex signalling on LSB is converted by a conventional ISO 9141 compatible

interface circuit 25 into separate Rx and Tx signal lines which connect to respective input and output pins on the controller.

The controller 22 communicates with respective controllers in the slave devices in a frame format comprising a plurality of words, each word comprising 1 start bit, 9 data bits and 1 stop bit. The controller 22 intermittently transmits a polling frame including a header word, a body comprising up to 8 words and a 1 word checksum onto the bus, LSB. The header word includes a four bit frame ID, a four bit negated frame ID, for error checking, with the 9th bit always set to 1. The nine bit format allows for a parity bit to be used for each word in the body although this is not necessary. The checksum is a modulo 256-sum of the data bytes.

If a slave controller sees a frame for which it is to respond, it replies by transmitting a frame including the relevant data back to the controller 22.

Figure 4 is a schematic illustration of a first embodiment of the RCM 42 contained in the roof housing 16. In the first embodiment, the RCM 42 includes a Motorola MC68HC05D9 microcontroller 30 mounted on a PCB in the roof housing 16. The RCM controller 30 communicates with the UCM controller 22 via the bus LSB, through connectors CN0 and CN3 on the UCM and RCM PCBs respectively. The half-duplex signalling on LSB is converted by an interface circuit 31 circuit corresponding to the interface circuit 25 of the UCM 40 which converts the LSB signal into separate Rx and Tx signal lines which connect to respective input and output pins on the controller 30.

The RCM controller 30 is connected to three switches FL, Gen and FR mounted on the RCM PCB in the roof housing 16. Each switch includes switch contacts located behind respective buttons exposed at the surface of the roof housing 16 which are actuable from within the vehicle cabin to open and close the switch contacts. Each switch has an associated LED L1, L2, L3 which are wired in series and connected between a protected battery voltage 12V nominal and via a current limiting resistor RL to the collector of a transistor Q1. The base of Q1 is connected to a digital output pin LED O/P via a resistor-divider network RD5, RD6. In low ambient light conditions, as determined by the controller 30 over the CAN network, LED O/P is switched high to turn on the transistor Q1 and light the LED's which in turn illuminate the buttons of their respective switches FL, Gen, FR.

The RCM controller 30 is further connected to a sun-roof switch 32 also mounted within the roof housing 16, Figure 2, the switch 32 also having an LED for inbuilt illumination of the switch. A suitable switch is manufactured by Alps Electric Co. Ltd. Japan. The switch 32 is connected to the controller 30 via a multi-wire flexible cable to a connector CN2 on the RCM PCB. The collector of the transistor Q1 is connected via a driver circuit 33 to a pin, Light, on the connector CN2 so that when LED O/P is switched high, the sun-roof switch is also illuminated.

The sun-roof switch includes outputs indicating the direction a user wishes to move the sun-roof 14 - forward (FWD), backward(BWD), tilt (Tilt) and automatic open (Auto). Each output is connected to a respective input pin on the controller 30 via the connector CN2. When any output changes state, the controller 30 waits

to be polled by the UCM controller 22 before transmitting the information relating to the change of state of the switch 32.

The UCM controller 22 then polls the controller (not shown) in the SRCM 44 via LSB to communicate the position of the sun-roof switch to the SRCM. The sun-roof controller then moves the sun-roof, or not, in the appropriate direction. It will be seen that because the sun-roof switch 32 is not connected directly to the sun-roof 14, but via the UCM 40, the conditions under which the roof opens/closes or tilts can be user specified.

The technique whereby the RCM controller 30 communicates a change in state of an input to the UCM controller 22 which in turn instructs a slave node, for example the RCM 42 itself, to actuate an output, is also applied to the switching of lamps located around the vehicle.

A number of such lamps are mounted on the RCM PCB in the roof housing 16, that is, two general lamps GEN1, GEN2 and left and right front reading lamps FLL and FRL, Figs. 2 and 4. Each lamp is switched by an output pin of the controller 30 via one channel of a quad high side driver SW1 to the battery voltage Vbb. The RCM controller 30 is further connected to vanity lamps (not shown) located above two front sun-visors and two rear side rail reading lamps (not shown) through a second quad high side driver SW2. These lamps and the respective switches (not shown) for the side rail reading lamps are connected to the RCM PCB via the connector CN3.

The RCM 42 uses PWM control to ramp the voltage supply

when turning on the general lamps GEN1 and GEN2, and to control the final voltage supplied to the general lamps as well as the voltage supplied to the vanity lamp and to the front reading lamps FLL, FRL to prevent overdriving the lamps due to variations in the battery level Vbb.

The general lamps GEN1, GEN2 are both ramped on when a vehicle door is opened, or when the Gen switch is closed, in the following manner. In the former case the opening of a door is signalled across the CAN bus to the UCM controller 22 in known manner, while in the latter case the controller 30 reports the closure of the Gen switch to the UCM controller 22. In either case the controller 22 then instructs the RCM controller 30 across the bus LSB to turn on the general lamps GEN1, GEN2 by specifying a maximum PWM duty cycle of a 5v PWM output pin, General. This specified maximum PWM duty cycle is inversely proportional to the battery voltage Vbb, which is determined by the UCM controller 22 via a resistor-divider network RD3, RD4, Figure 3.

The General output pin is connected to two inputs on the quad high side driver SW1. When enabled by a 5v signal from the General output pin, these inputs connect the battery voltage Vbb to the respective general lamps GEN1, GEN2; thus the battery voltage supplied to the lamps GEN1, GEN2 is pulse width modulated with the same instantaneous duty cycle as the voltage at the General output pin.

The RCM controller 30 steps the General output from 0% to the maximum PWM duty cycle specified by the UCM controller 22 over a pre-determined number of steps as a function of time. By matching the step increments to

the increasing resistance value of the lamp filaments as they heat up, the power dissipated by the lamps is ramped approximately linearly and so the problem of lamp failure due to thermal shock is mitigated as well as providing an enhanced visual effect.

Similarly, the RCM controller 30 is instructed to turn on the front reading lamps FLL, FRL and the vanity lamp located in the sun visor by the UCM controller 22. In the case of the front reading lamps, the RCM controller 30 detects the closing of switch FL or FR and reports this to the UCM controller 22. The UCM controller 22 then instructs the RCM controller 30 to turn on the respective lamp FLL or FRL by enabling output F1 or F2 and specifying a constant PWM duty cycle of the voltage at an output, PWM Const, of the controller 30. As before, the specified PWM duty cycle is inversely proportional to battery level.

In the case of the vanity lamp, the RCM controller 30 is instructed to switch the vanity lamp on by the UCM controller 22 when the latter sees across the CAN bus that the sun-visor has been pulled down. This is done by enabling the Vanity output of the controller 30 and again specifying a constant PWM duty cycle of the voltage at the output PWM Const inversely proportional to battery level.

Each of the outputs F1, F2 and Vanity is "anded" with the output PWM Const so that only that lamp whose output from the controller 30 is enabled will illuminate. It will be observed that in contrast to the general lamps, the reading and vanity lamps are not ramped up but are switched on immediately to the specified constant PWM duty cycle. This reduces the amount of software control

that would have been required to produce three independent PWM signals.

It will be recognised that the conditions under which the any of the lamps connected to the RCM 42 are switched on and off can be customised by programming the UCM controller 22. For example, the controller 22 could be programmed to ignore the opening of a door or the switching on of one of the switches FL, Gen or FR if it determined that the ambient light level were sufficiently high not to warrant turning on the corresponding lamp. The voltage at the junctions of the resistors RA, RG, RB which control the electro-optic cell 28 could be used for determining ambient light level for this purpose, or as in the present embodiment the ambient light level can be determined by the UCM controller 22 across the CAN bus from a separate light sensor.

The RCM 42 is also connected to a climate control unit 53 comprising a fan and a thermistor (not shown). Power is supplied to the fan from the RCM 42. A Fan output of the controller 30 is connected to an input of the driver SW2. The corresponding output of the driver SW2 is connected to a pin FAN on a connector CN4. The thermistor has two terminals connected directly to respective pins THS, TLS on the connector CN4. These pins are connected to respective pins on the connector CN3 which are in turn connected via the vehicle harness to respective pins on the UCM connector CN0. The differential signal is passed through conditioning circuitry 27 and connected to an analog input Temp of the UCM controller 22. The temperature of the vehicle cabin can thus be relayed by the UCM controller to any other nodes across the network.

For example, if the temperature of the cabin rose to dangerous levels while the vehicle were stationary and, if the presence of a person in the vehicle were detected by a seat occupancy detector (see below), the sun-roof could be instructed to open slightly by the SRCM. Similarly, if a rain sensor (see below) indicates rain, the SRCM may not open the sun-roof.

The UCM controller 22 also controls the remote keyless entry RKE unit 20 which is also mounted within the mirror housing 12. The UCM 40 is connected to the RKE unit 20 via a multi pin connector CN5. Among other signals, 5V power is supplied to the RKE unit 20 from the RKE Power output pin on the controller 22 via one connector pin and data is returned by the RKE unit 20 to the RKE Data input pin on the controller 22 via the second connector pin.

It will be seen that it is not desirable for all of the vehicle electronics to be drawing battery power while the vehicle is stationary without its engine running for more than a pre-determined time. The CAN nodes of the network therefore enters a low power sleep mode.

In the present embodiment, a wake up timer has a frequency approximately 3Hz and is connected to an input pin of the UCM controller 22. When interrupted, the controller 22 interrogates the RKE unit 20 to determine if the vehicle is to be entered legitimately. During at least one of these interrupts, the controller 22 also sends a message to the SCM via LSB to tell the siren that the network is functioning normally and that an alarm is not to sound.

Battery power to the slave nodes RCM 42 and SRCM 44 as well as a mass motion sensor unit (MMS) is switched by

the UCM 40. An RCM power output pin (RCM Power O/P) is connected to an input channel of a quad high side driver SW0 on the UCM PCB. A signal on this pin connects the battery voltage Vbb to a line RES which connects to the connector CN3 on the RCM PCB via the connector CN0 on the UCM PCB. The RES signal is in turn channelled by the connector CN3 to the SRCM 44 on line SSS. Thus, when in sleep mode the UCM 40 can remove power from the RCM and SRCM slave nodes in the master-slave network.

An Alarm output of the UCM controller is independently connected to an input of the driver SW0. A corresponding output pin of the driver is connected to a pin (Alarm Power) on the connector CN0 which is connected via the vehicle harness to the MMS. Thus, the UCM 40 can remove power from the MMS when the vehicle has been legitimately entered, so that the ADA signal is not asserted.

The MMS supplies a sensor output signal ADA to the UCM controller 22 via a mass motion sensor interface (MMS I/F). The UCM controller 22 is therefore able to determine whether an alarm should sound. It should be understood that the ADA signal will be active as soon as someone enters the vehicle illegally.

The mirror housing 12 also includes seat belt warning lamps 15, Fig. 3. These lamps are connected in series to the collector of a transistor Q2 whose base is connected to an output pin of the controller 22. In the present embodiment, when the vehicle ignition is turned on, the UCM controller 22 flashes the seat belt warning lamps 15 for a pre-determined time or until the UCM is instructed over the CAN bus to stop. The lamps are displayed prominently on the mirror housing 12 where

they are sure to be noticed by any occupants of the vehicle.

In a typical CAN network, vehicle parameter values are usually calculated at one node. If another node wishes to determine the value of the parameter, it monitors the value across the network. It will be seen, however, that due to the limitation in the number of message identifiers and bandwidth of the network, there is a cost in software in communicating sensor/actuator values across the network. For this reason, it is advantageous to hardwire certain signals within the vehicle control system.

In a second embodiment of the RCM 42, Figure 6, the microcontroller 30 is removed, and the roof housing electronics including the lights and switches are controlled directly by the UCM controller 22 across the vehicle harness via hard wire connections. The required changes are described with reference to the RCM 42 only, with changes being made mutatis mutandi to the UCM 40.

For ease of mounting within the roof housing 16, the RCM 42 comprises two separate PCB's, PCB A and PCB B, linked together via a multi-wire cable. In the second embodiment, the three switches FL, Gen and FR of the first embodiment are mounted on PCB A, and their respective outputs are encoded into a two wire output by encoding circuitry 61. The two wire output is connected via a connector CN6 across the multi-wire cable to a connector CN7 on PCB B. The two wires are then further connected via another connector CN8 to the vehicle harness which in turn connects the two wire output to the UCM 40. The two wire output is decoded either by dedicated decoding circuitry or within the UCM controller 22 to determine the status of the switches.

A light output corresponding to the LED O/P from the controller 30 of the first embodiment is directly connected between the UCM controller 22 and the switches FL, Gen and FR in the second embodiment. The light output is connected via the connectors CN8, CN6 and CN7 and the three wire cable to power the switches as before.

In both the first and second embodiments, placing of the sun-roof switch 32 is optional. In the second embodiment, the switch 32 is connected to the PCB B via multi-wire cable and a connector CN2' corresponding to CN2 of the first embodiment. When placed, the four switch outputs FWD, BWD, Tilt and Auto are further connected to the sun-roof control module SRCM 44 via a connector CN9. This obviates the need for the UCM 40 to communicate the status of the switch 32 to the SRCM 44 as in the first embodiment. In order to illuminate the switch 32, the light output is connected via the connector CN2' to the switch 32 so that, when placed, the sun-roof switch 32 is illuminated with the buttons FL, Gen and FR.

Because the FWD signal from the switch 32 is critical, it is split on the PCB B, and a duplicate signal FWD 2, is connected via the connector CN8 and a separate portion of the vehicle harness to the SRCM 44.

Placing of the fan unit 53 is also optional. In the second embodiment, the unit 53 is connected to the PCB B via a connector CN4' corresponding to CN4 of the first embodiment. The three signals FAN, TLS and THS are connected to the UCM 40 as before.

In the second embodiment, the four lamps GEN1, GEN2, FLL

and FRL are controlled directly by the UCM 40. Three pulse width modulated control signals, corresponding to General and the outputs of the gates A1 and A2 of Figure 4 are generated by the UCM 40 rather than within the RCM, and are connected via the vehicle harness to the connector CN8 from which they are connected to the lamps.

It will be appreciated by those skilled in the art that the invention can be used to control a prismatic mirror rather than an electro-optic mirror as described. Prismatic mirrors are well known in the art and include a prism which can be moved between first and second angular positions providing different degrees of reflectivity as seen by the driver. In the context of the present invention such a prism can be motor driven between its first and second positions, to achieve a variable reflectivity mirror, with control of the motor being effected by the UCM controller 22 in accordance with the signals from the ambient light sense resistors RA, RG and RB. Since prismatic mirrors normally have only two states, PWM would not be necessary in that case and the output from the controller 22 could be a single signal which was either on or off according to the desired angular position of the prism. Alternatively, a prismatic mirror can be manually actuated between two angular positions to give a variable reflectance mirror.

Also, while the invention has been described herein in terms of a CAN network, the invention could alternatively be implemented in any other suitable network, for example a network conforming to the French standard VAN (Vehicle Area Network) or the US standard J1850, or a purpose designed proprietary network could be used.

It will be further appreciated by those skilled in the art that various other vehicle components and systems may be associated with the vehicle control system and/or rearview mirror as described herein. For example, a battery level indicator, various lighting systems, vehicle tyre indicators, blind spot warning data, GPS antenna and directional information, intelligent vehicle highway system information, safety warning system information, rain sensor information provided by windshield contacting or non-contacting sensors, compass information for example from flux gate, magneto inductive or magneto resistive compasses, temperature information, trainable or universal garage door opening systems, vehicle seat positioning and occupancy detection systems, intrusion detection systems, cellular telephone and pager systems, emergency rescue systems, sun-roof (which could be electro-optic) control system and memory storage of various functions and data applicable to the above in addition to any other desirable vehicular information.

It will also be seen that the vehicle control system can be used to control one or more outside electro-optic, for example, electrochromic mirrors (not shown). This can be achieved by hardwiring the UCM 40 to the or each outside mirror, similar to the way in which the vanity lights are connected to the RCM 42; or by connecting the UCM via the bus LSB to one or more slave outside mirror controllers (not shown) which control the or each outside mirror; or by connecting the UCM via the CAN bus to a another CAN node for controlling the or each outside mirror.

The invention is not limited to the embodiments described herein which may be modified or varied without departing from the scope of the invention.

CLAIMS

1. A vehicle rearview mirror comprising a mirror housing containing a variable reflectivity mirror unit and a microcontroller for controlling the reflectivity of the mirror unit.

2. A vehicle rearview mirror according to claim 1, further including connection means adapted to connect the microcontroller to a vehicle control network, the microcontroller forming a node of said network.

3. A vehicle rearview mirror according to claim 2, wherein the mirror housing further includes at least one seat belt warning lamp for indicating that seat belts should be fastened.

4. A vehicle rearview mirror according to claim 2, wherein the mirror housing further includes a remote keyless entry device.

5. A vehicle rearview mirror according to claim 2, wherein the vehicle control network is a CAN network and the node is a CAN node.

6. A vehicle rearview mirror according to claim 2, wherein the connection means is further adapted to connect the microcontroller in the mirror housing to a further microcontroller located exterior to the mirror housing, the microcontroller in the mirror housing and the further microcontroller being in master/slave relationship.

7. A vehicle rearview mirror according to claim 6, wherein the master microcontroller communicates with the

slave microcontroller according to an ISO 9141 communication protocol.

8. A vehicle rearview mirror according to claim 1, wherein the reflectivity of the mirror unit is varied under software control according to a selected value of at least one parameter.

9. A vehicle rearview mirror according to claim 1, wherein the microcontroller controls the reflectivity of the mirror unit according to the state of at least one ambient light sensor.

10. A vehicle rearview mirror according to claim 9, wherein the mirror unit includes an electro-optic cell whose transmissivity is determined in accordance with the duty cycle of a pulse width modulated signal provided by the microcontroller.

11. A vehicle rearview mirror according to claim 10, wherein said pulse width modulated signal is smoothed to provide a substantially constant voltage signal which is applied to the cell.

12. A vehicle control system comprising a rearview mirror housing, a variable reflectivity mirror unit mounted in the mirror housing, a first microcontroller mounted in the mirror housing for controlling the reflectivity of the mirror unit, a second microcontroller mounted in the vehicle outside the mirror housing and connected to the first microcontroller, and at least one input and/or output device connected to the second microcontroller.

13. A vehicle control system according to claim 12, wherein the first microcontroller is a master microcontroller and the second microcontroller is a slave microcontroller.

14. A vehicle control system as claimed in claim 12, further including a roof housing positioned on the interior roof of the vehicle, the second microcontroller being mounted in the roof housing.

15. A vehicle control system according to claim 12, wherein the first microcontroller controls the reflectivity of the mirror according to the state of at least one ambient light sensor.

16. A vehicle control system according to claim 15, wherein the mirror unit includes an electro-optic cell whose transmissivity is determined in accordance with the duty cycle of a pulse width modulated signal provided by the first microcontroller.

17. A vehicle control system according to claim 16, wherein said pulse width modulated signal is smoothed to provide a substantially constant voltage signal which is applied to the cell.

18. A vehicle control system according to claim 14, wherein the roof housing contains at least one vehicle interior lamp and the second microcontroller controls the operation of the lamp.

19. A vehicle control system according to claim 18, wherein the vehicle interior lamp is turned on by the second microcontroller upon opening of a vehicle door,

and wherein the power dissipated by the lamp upon said turning on is gradually increased from zero to a maximum which is a function of the vehicle battery voltage.

20. A vehicle control system according to claim 19, wherein the power dissipated the lamp is determined in accordance with the duty cycle of a pulse width modulated signal provided by the second microcontroller.

21. A vehicle control system according to claim 13, wherein the master microcontroller is a node on a vehicle control network.

22. A vehicle control system according to claim 21, wherein the master microcontroller communicates with the slave microcontroller according to an ISO 9141 communication protocol.

23. A vehicle control system according to claim 13, wherein at least two slave microcontrollers are connected to the master controller, and wherein the master microcontroller controls an output device connected to one of said slave microcontrollers in response to an input device connected to the other of said slave microcontrollers.

24. A vehicle control system comprising a network controlling a plurality of functions of the vehicle, the network having a node located in a rearview mirror housing of the vehicle, such node controlling at least one function of the mirror.

25. A vehicle control system according to claim 24, wherein said node also forms part of a local sector network including at least one further node in addition

to said node, said node and said further node being connected in master/slave relationship.

26. A vehicle control system according to claim 24 or 25, further including a roof housing positioned on the interior roof of the vehicle, said housing including at least one input and/or output device, the or each device being controlled directly by the node.

27. Apparatus for determining an optical characteristic of a vehicle component in accordance with the duty cycle of a pulse width modulated signal.

28. Apparatus according to claim 27, wherein the component is a rearview mirror unit and the characteristic is its reflectivity.

29. Apparatus according to claim 27, wherein the component is an interior lamp and the characteristic is its brightness.

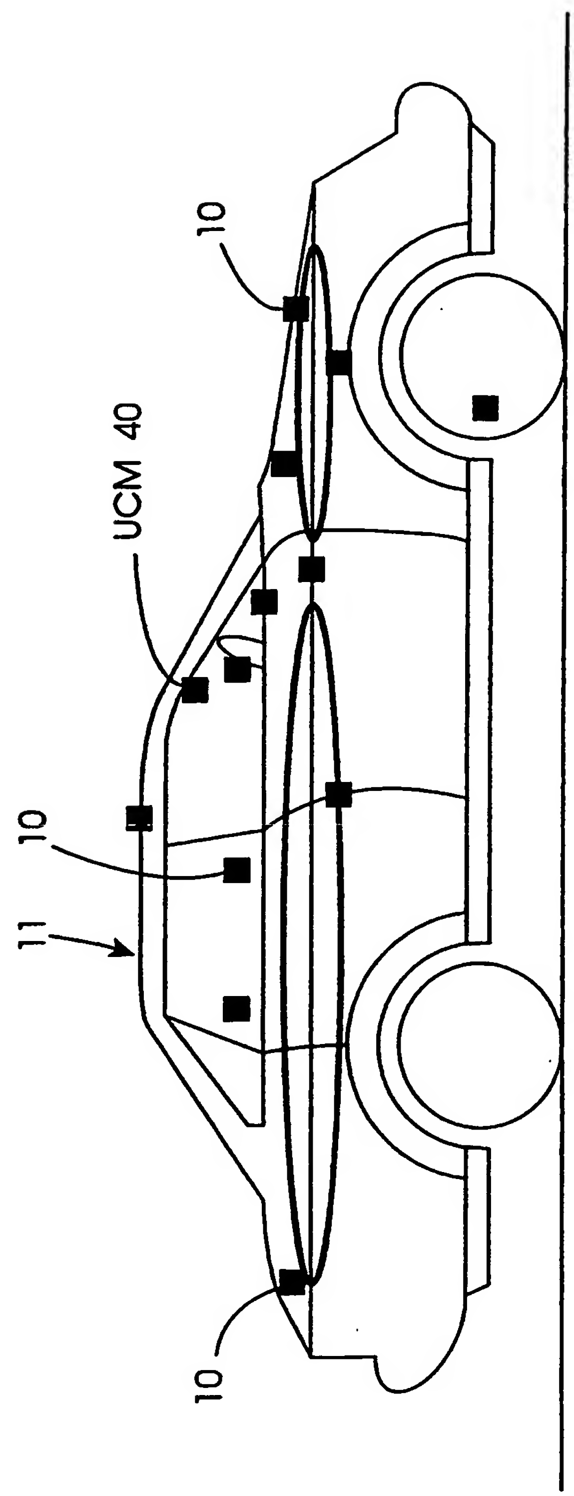


Figure 1

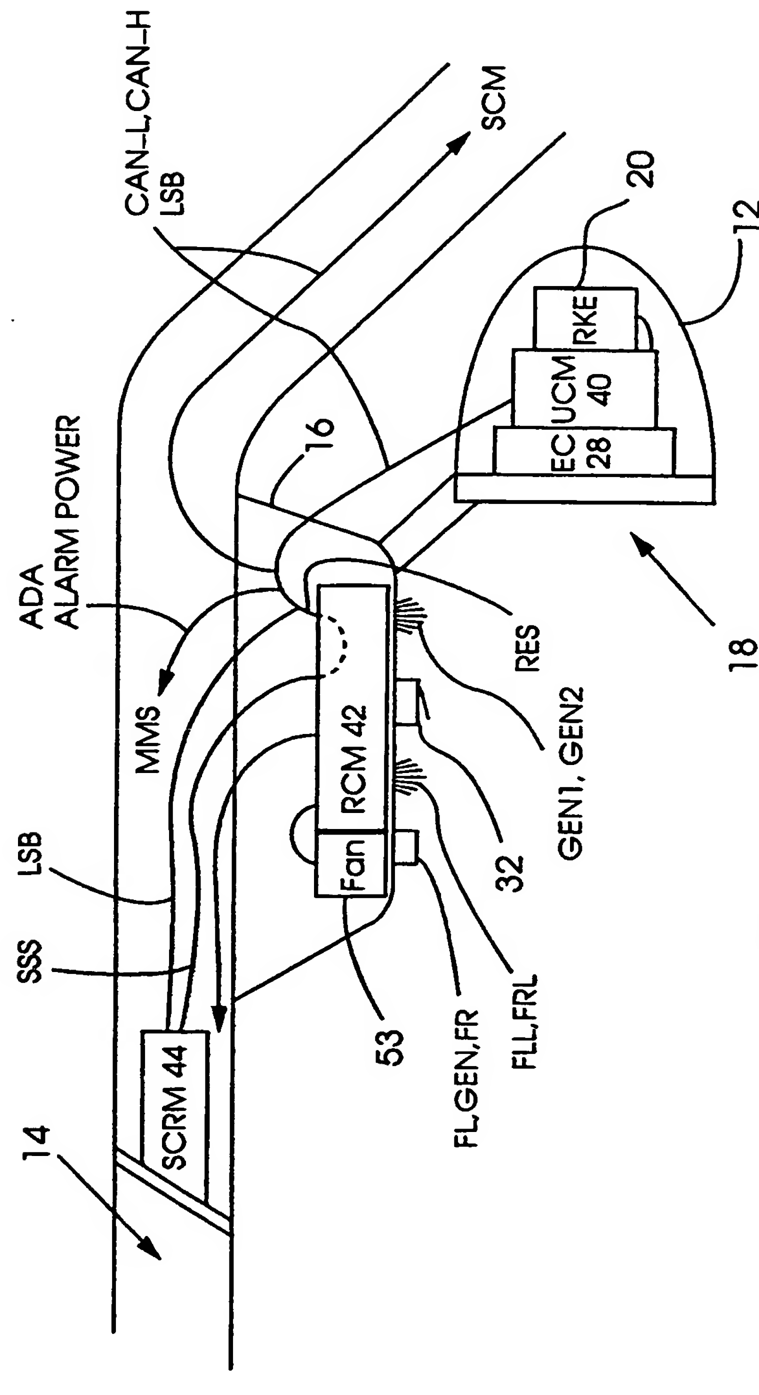
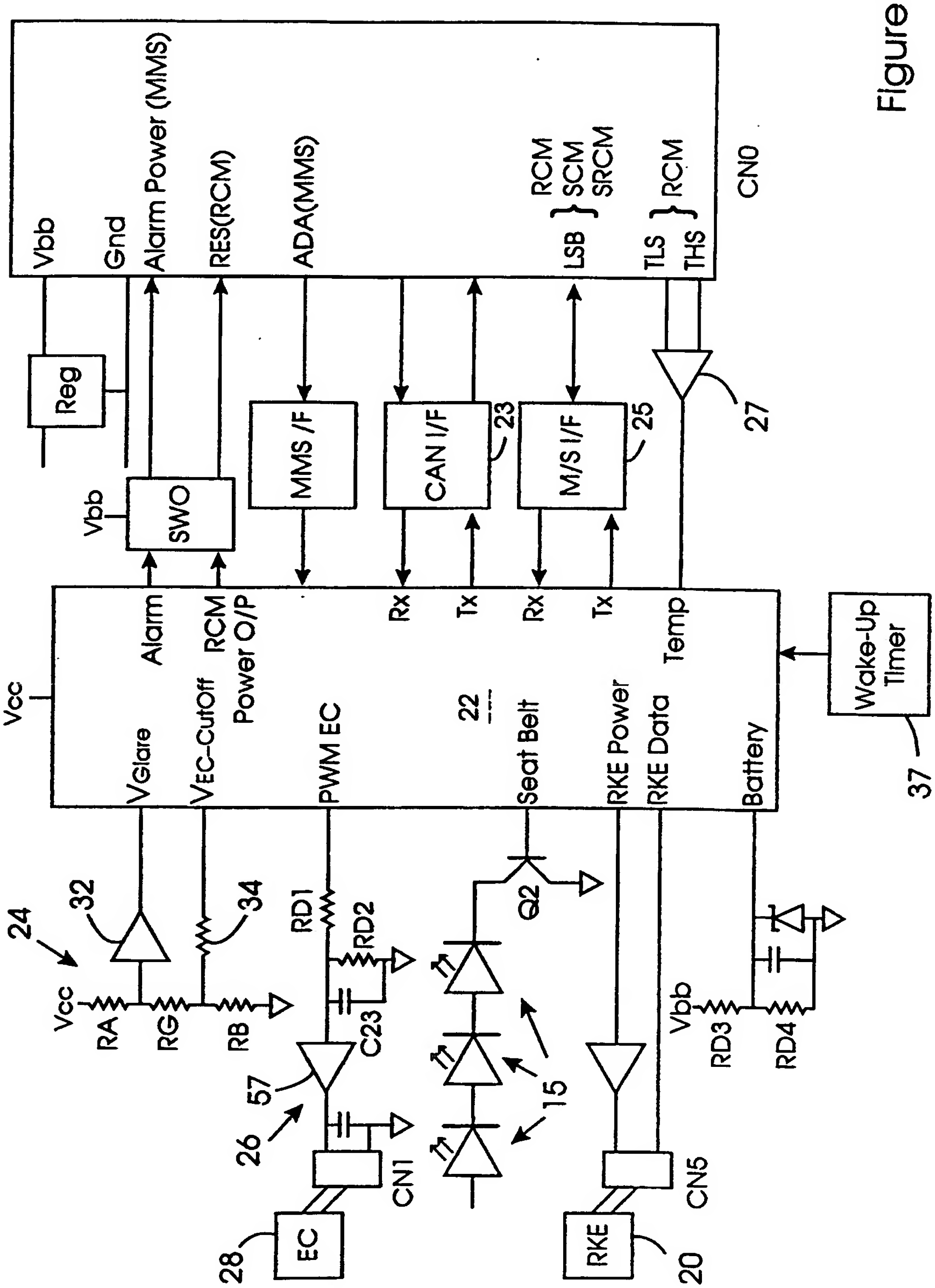

CAN–L,CAN–H
LSB
SCM
20
12
RKE
UCM
40
EC
28
16
ADA
ALARM POWER
MMS
RES
18
RCM 42
GEN1, GEN2
32
Fan
LSB
SSS
53
FLL,FRL
FL,GEN,FR
SCRM 44
14

Figure 2


Vbb
Gnd
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RES(RCM)
ADA(MMS)
LSB
RCM
SCM
SRCM
TLS
THS
RCM
CN0
Reg
Vbb
SWO
MMS /F
CAN I/F
23
M/S I/F
25
27
Vcc
Alarm
RCM
Power O/P
Rx
Tx
Rx
Tx
Temp
VGlare
VEC-CutOff
PWM EC
22
Seat Belt
RKE Power
RKE Data
Battery
Wake-Up
Timer
37
24
32
34
Vcc
RA
RG
RB
RD1
RD2
C23
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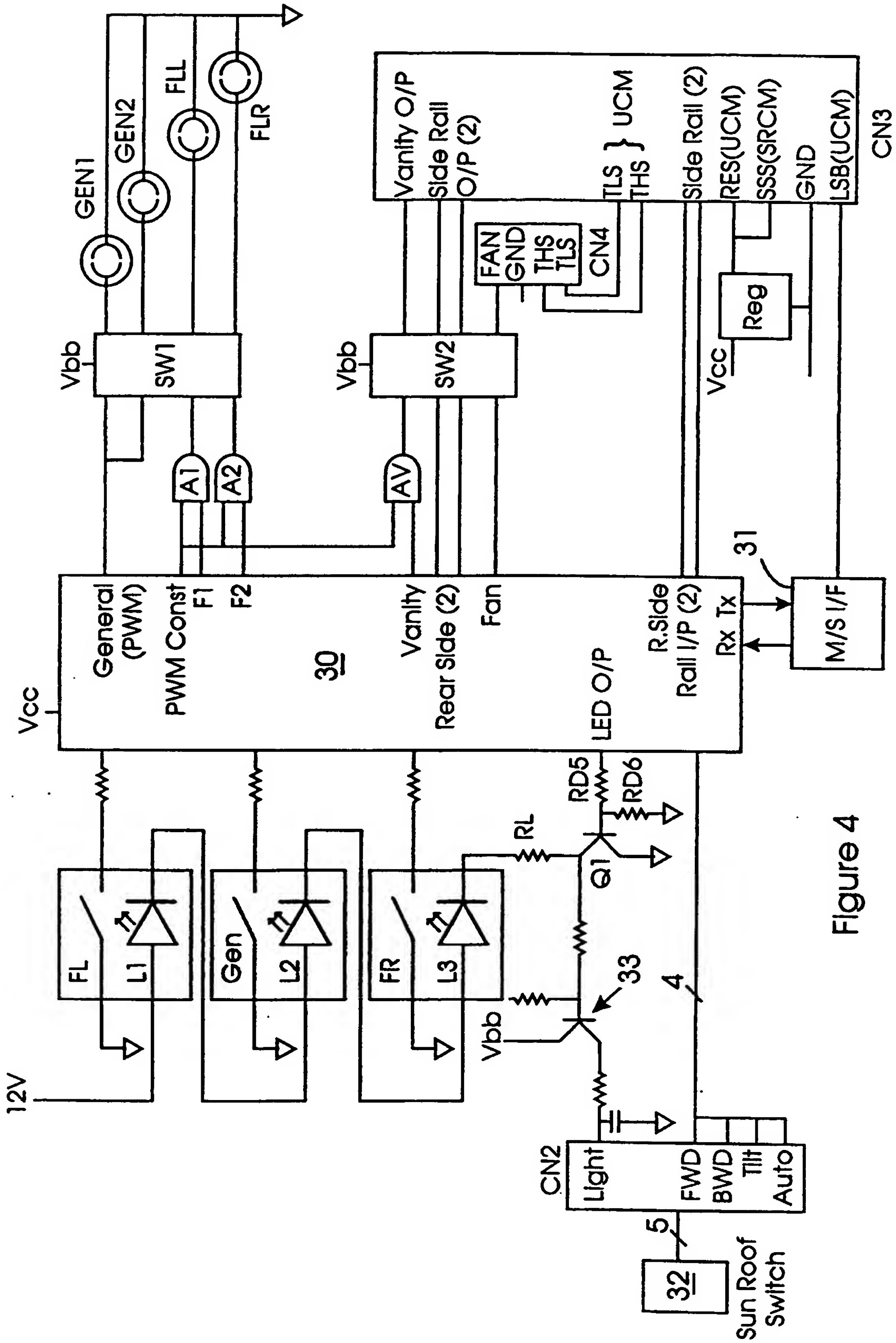
26
CN1
EC
28
Q2
15
CN5
RKE
20
Vbb
RD3
RD4

Figure 3


GEN1
GEN2
FLL
FLR
Vanity O/P
Side Rail O/P (2)
TLS
THS
UCM
Side Rail (2)
RES(UCM)
SSS(SRCM)
GND
LSB(UCM)
CN3
FAN
GND
THS
TLS
CN4
Reg
Vcc
Vbb
SW1
Vbb
SW2
A1
A2
AV
31
M/S I/F
Vcc
General (PWM)
PWM Const
F1
F2
30
Vanity
Rear Side (2)
Fan
LED O/P
R.Side Rail I/P (2)
Rx Tx
RD5
RD6
RL
Q1
33
4
FL
L1
Gen
L2
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Vbb
CN2
Light
FWD
BWD
Tilt
Auto
5
32
Sun Roof Switch
Figure 4

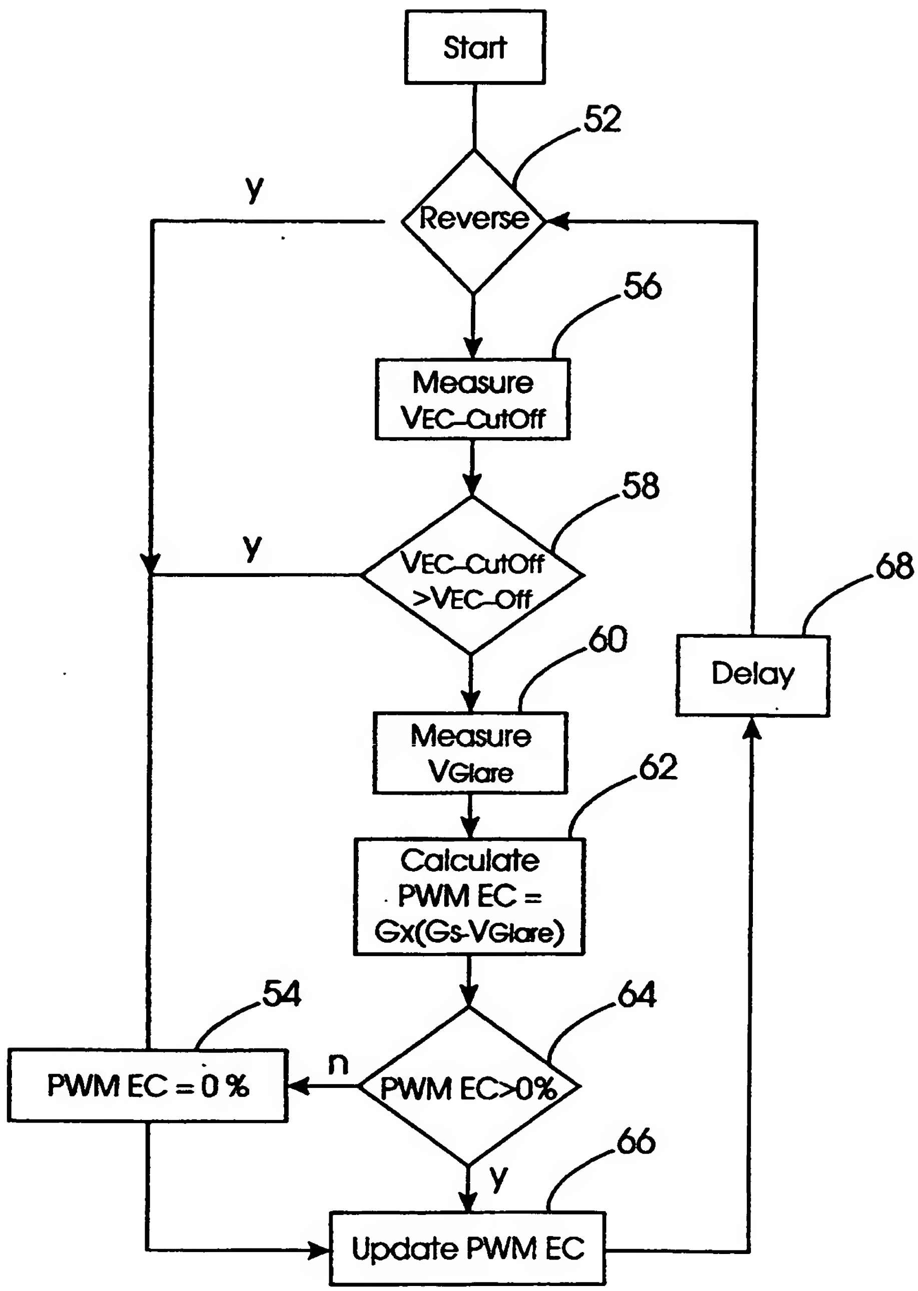
Start
52
Reverse
y
56
Measure
VEC-CutOff
58
VEC-CutOff
>VEC-Off
y
60
Measure
VGlare
62
Calculate
PWM EC =
Gx(Gs-VGlare)
54
64
PWM EC = 0 %
n
PWM EC>0%
y
66
Update PWM EC
68
Delay

Figure 5

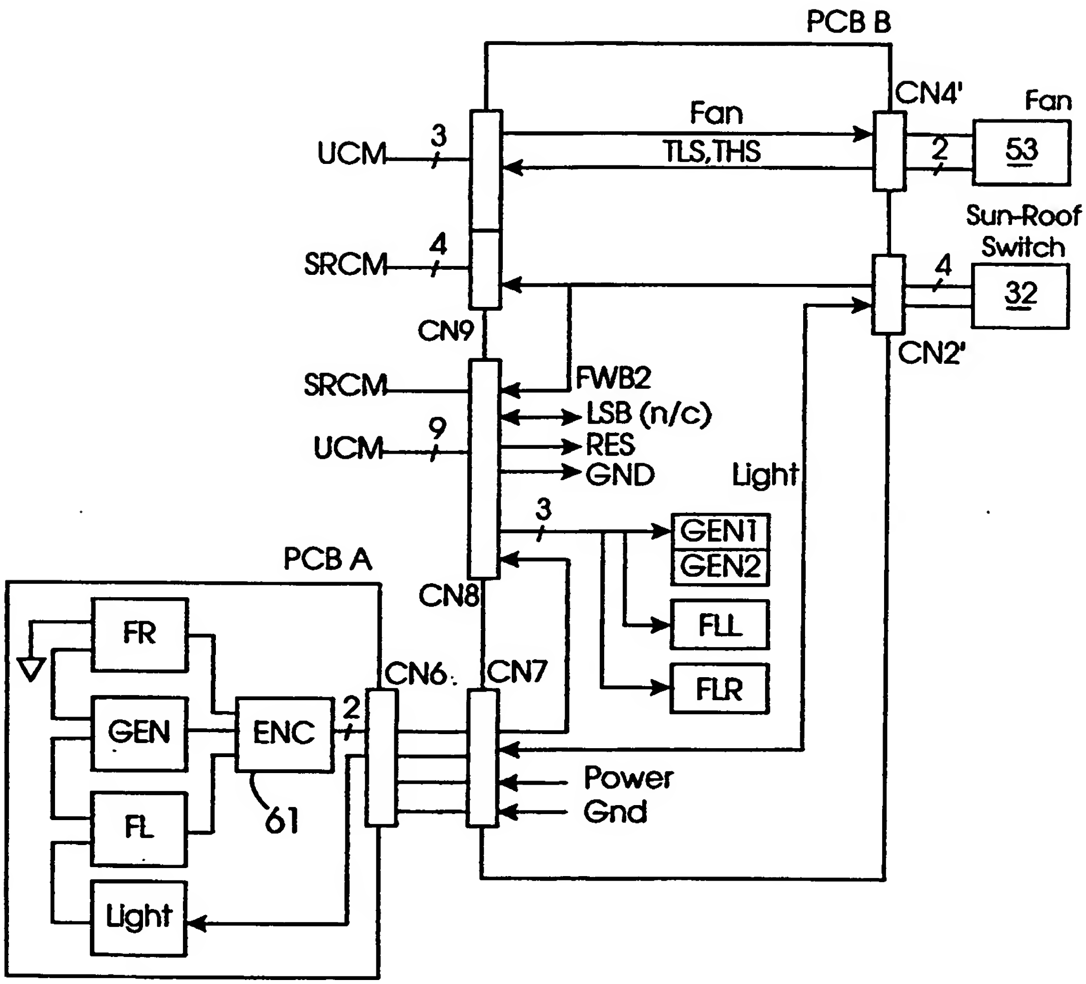
PCB B
CN4'
Fan
Fan
UCM
3
TLS,THS
2
53
Sun-Roof
Switch
SRCM
4
4
32
CN9
CN2'
SRCM
FWB2
LSB (n/c)
UCM
9
RES
GND
Light
3
GEN1
GEN2
PCB A
CN8
FLL
FR
CN6
CN7
FLR
GEN
ENC
2
Power
Gnd
61
FL
Light

Figure 6

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IE 98/00001

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 B60R1/08

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B60R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 451 822 A (BECHTEL JON H ET AL) 19 September 1995	1,8,9
Y	see column 2, line 40 - column 3, line 59	2,5-7, 10-15, 21-26
	see column 7, line 64 - column 11, line 9 see column 13, line 48 - column 17, line 9; figures 1-6T	

Y	DE 43 40 048 A (BOSCH GMBH ROBERT) 1 June 1995	2,5-7, 10-15, 21-26
	see column 1, line 52 - column 8, line 12; figures 1-4	

	-/--	

[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publicationdate of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

1

Date of the actual completion of theinternational search	Date of mailing of the international search report
8 April 1998	16/04/1998
Name and mailing address of the ISA European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Authorized officer Geyer, J-L

Form PCT/ISA/210 (second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

International Application No
PCT/IE 98/00001

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X Y A	US 5 285 060 A (LARSON MARK L ET AL) 8 February 1994 see the whole document	27-29 10,11 16,17
A	EP 0 693 397 A (DONNELLY CORP) 24 January 1996 see the whole document	1-4,8,9
A	"ELECTRICITE" REVUE TECHNIQUE AUTOMOBILE, vol. 46, no. 528, 1 June 1991, pages XLVII-L, LIII - LIV, LVI, XP000231235 see the whole document	2,5,6, 18,19

1

Form PCT/ISA/210 (continuation of second sheet) (July 1992)

INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

PCT/IE 98/00001

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		WO 9515043 A	01-06-95
		EP 0730803 A	11-09-96
		JP 9505453 T	27-05-97
		PL 314582 A	16-09-96
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		US 5530240 A	25-06-96
EP 0693397 A	24-01-96	US 5715093 A	03-02-98